ネパールの温帯産ブナ科植物の枝材の比較解剖

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Lajmina JOSHI*: Comparative Anatomy of Branch Wood of Some Temperate Species of Nepalese Fagaceae.

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Abstract

Wood anatomy of branches of 12 native species (7 in *Quercus*, 2 in *Lithocarpus* and 3 in *Castanopsis*) belonging to the Fagaceae was studied. In all the species vessels are found to be radial porous and their perforation plates are simple. Intervascular pits are alternately arranged. Wood parenchyma is apotracheal but its arrangement is different in different species. Tracheids are present in all the species. Rays are of narrow and broad types. Based on the anatomical characters, diagnostic characters and phylogenetic relationships among the three genera are discussed.

Introduction

The Fagaceae, with over 600 species distributed worldwide, is one of the most important timber producing families. It has been subjected to the anatomical and taxonomic work carried out by many foresters and botanists (BAILEY, 1910 a, 1910 b ; EAMES, 1910 ; KOBAYASHI, 1953 ; SHIMAJI, 1962). There have been no reports of wood anatomical studies on the Nepalese Fagaceae. The present study concerns the morphological characters of the secondary xylem of branch wood of 12 species in 3 genera of Himalayan Fagaceae. The external foliar and floral characters are so variable and so easily subjected to modification that botanists have encountered some difficulties in constructing classifications of the Fagaceae, especially of the genera *Quercus* and *Lithocarpus*.

Materials and Methods

The present investigation deals with the wood anatomy of *Quercus delatata* LINDL., *Q. glauca* THUNB., *Q. incana* ROXB., *Q. lamellosa* SM., *Q. lanuginosa* D. DON, *Q. lineata* BL., *Q. semecarpifolia* SM., *Lithocarpus pachyphylla* (KURZ) REHDER, *L. spicata* REHDER et WILSON, *Castanopsis hystrix* MIQ., *C. indica* (ROXB.) MIQ. and *C. tribuloides* (SM.) A. DC. The study was carried out on branch wood with green living leaves from native forests or in the Botanic Garden, or on branches of the dried herbarium specimens deposited in the Herbarium, Department of Medicinal Plants, H. M. G. Nepal. The materials were boiled for one hour, washed, then fixed in formic acetic alcohol. Transverse, tangential, and radial sections were cut on the sledge microtome and stained using safranin and hematoxylin in the proportion of 1 : 4 (CUTLER, 1978). Maceration of wood was done following the method of TCHULTZ.

Observations

Wood in all the studied species is exclusively radial porous (Figs. 1-12). Growth rings are fairly distinct in *Q. semecarpifolia* and *Q. glauca*, but are faintly distinct or invisible in the other species. The pores are arranged in dendritic or stream-like patterns gradually decreasing in size from the early to the late wood. Pores are exclusively solitary in *Quercus lanuginosa*, *Q. semecarpifolia*, and *Lithocarpus pachyphylla*, while in other species they are in radial groups or in clusters of 2-3. The density of pores differs from species to species (Table 1). The highest density is found in *Q. incana* and the lowest in *Q. glauca*. Solitary pores are mostly orbicular or oval and sometimes a little angular and are thick-walled. Pore diameter and vessel length differs from species to species as shown in Table 1. Perforation plates are found to be exclusively simple and oval ; in most species end walls are nearly horizontal to oblique with or without tapering ends in one or both sides of the dements. Intervascular pitting is alternate in all the species. Pits are oval, elliptical, and bordered. Tyloses are present in *Q. semecarpifolia*, *Q. lanuginpsa*, *Q. glauca*, *Q. delatata*, *Q. incana*,

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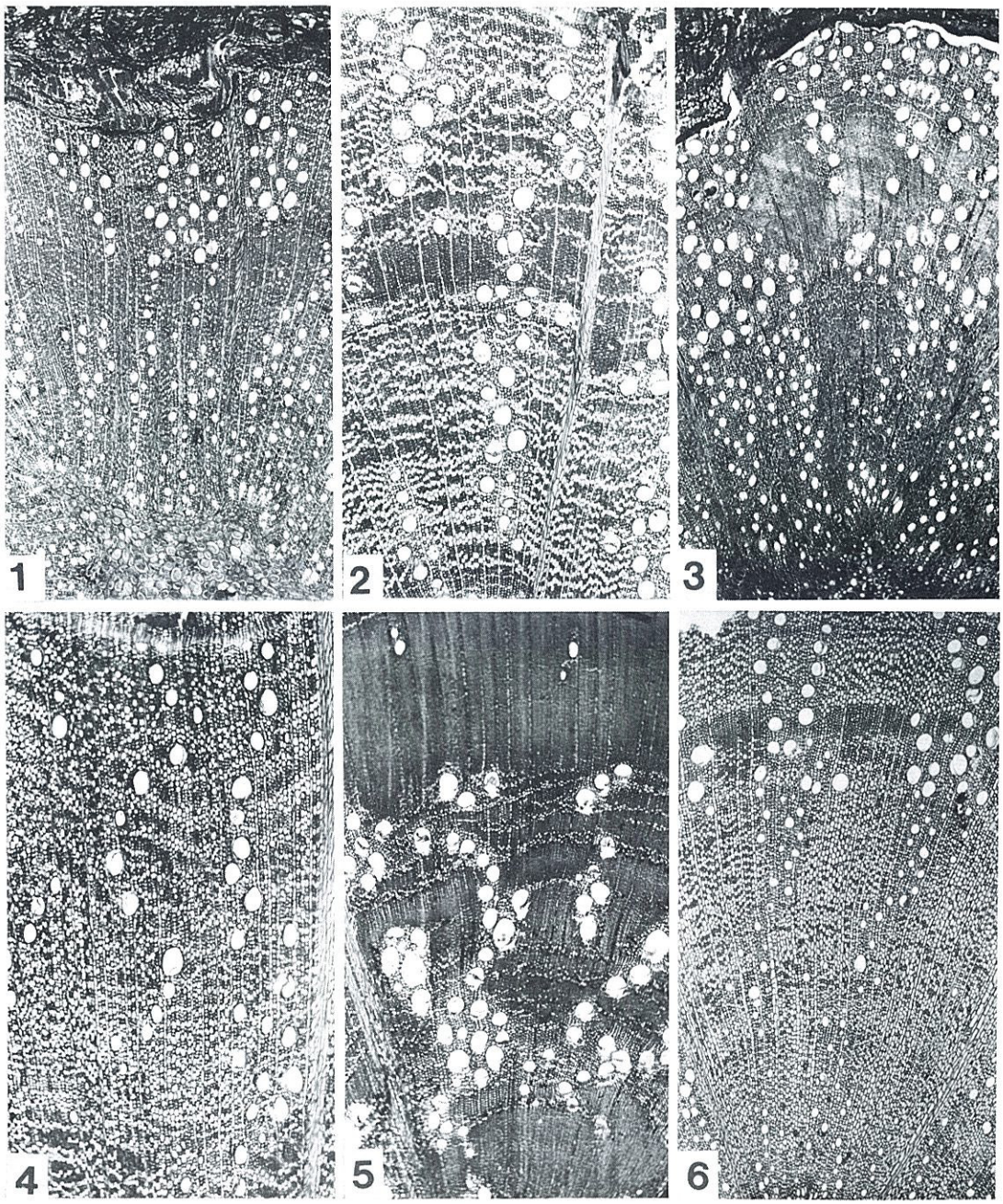
Castanopsis indica, and *C. hystrix*.

Non-perforated tracheal elements are vasicentric tracheids, fiber tracheids, and libriform fibers. In all the species investigated vasicentric tracheids are slightly flattened n cross section; pits vary in shape, being oval and horizontally long elliptical with wide lumen. Fiber tracheids and libriform fibers constitute the ground mass of wood. They are oval and angular in the cross section, with thick walls. The length and the wall thickness of the fibrous elements vary, as in vessel elements. Septate fibers were found only in *Quercus lanuginosa*. Pits are simple with slit-like or elliptical apertures in a vertical row. Not much

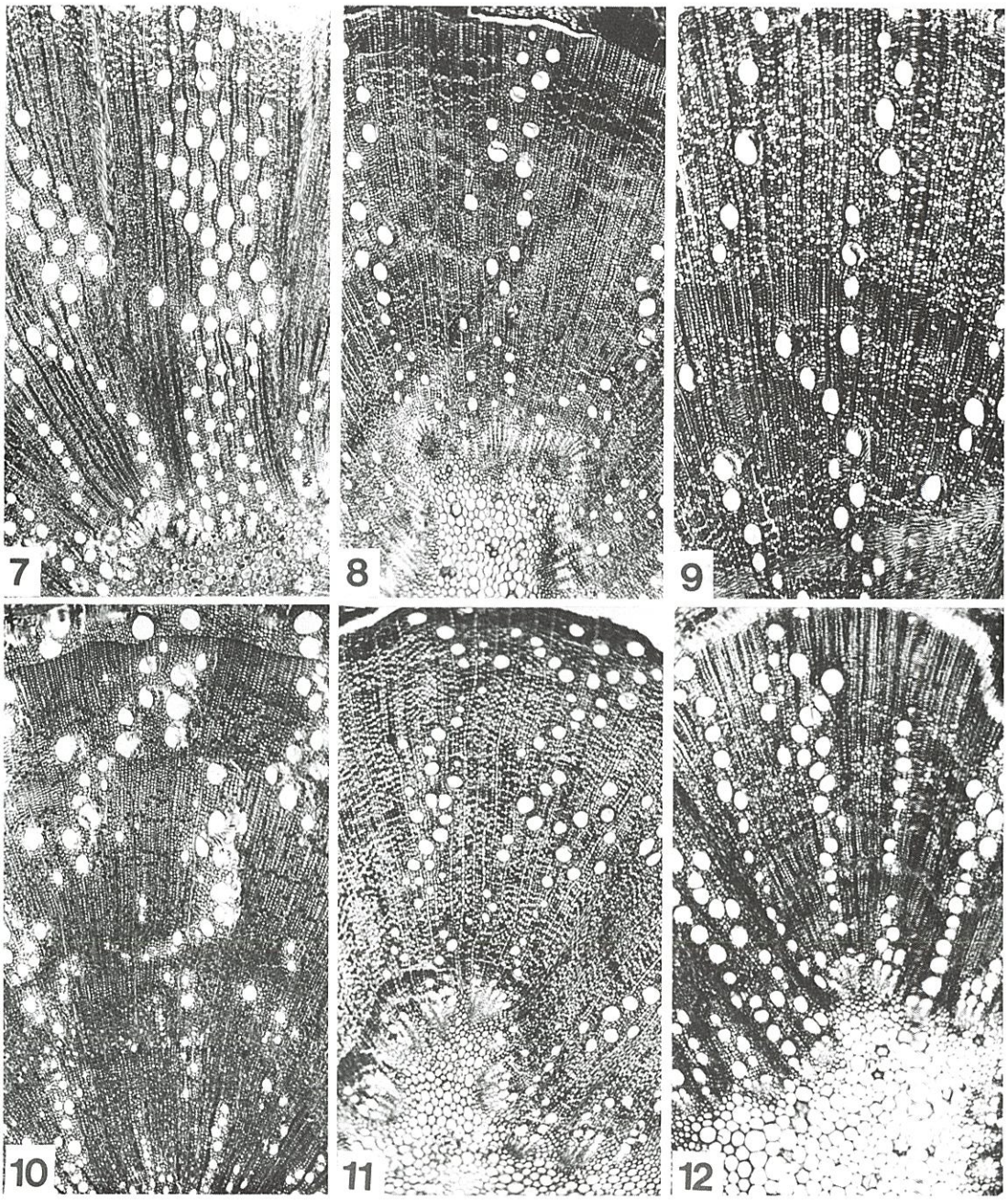


Figs. 1-6. Cross sections of branch wood of *Quercus* (×40). 1: *Q. delatata*, 2: *Q. glauca*, 3: *Q. incana*, 4: *Q. lamellosa*, 5: *Q. lanuginosa*, 5: *Q. lineata*.

difference is found in diameter of the fibers.

In all the species wood parenchyma is apotracheal, but its mode of arrangement varies from species to species (Table 2). It is scattered in short uniseriate bands in *Q. delatata* and *C. indica*, diffuse in *Q. incana* and *C. hystrix*, diffuse in aggregate in *Q. lineata*, *C. tribuloides* and *L. spicata*. But in *Q. glauca*, *Q. semecarpifolia* and *Q. lamellosa*, parenchyma is diffuse in aggregate and banded whereas in *Q. lanuginosa* and *L. pachyphylla* it is banded, but not aggregate (2-5 seriate). Many minute simple pits are found on the walls of the parenchyma.

Rays are unstoried and heterogeneous. Two



Figs. 7-12. Cross sections of branch wood of *Quercus*, *Lithocarpus and Castanopsis* (×40). 7 : *Q. semecarpifolia*, 8 : *L. pachyphylla*, 9 : *L. spicata*, 10 : *C. hystrix*, 11 : *C. indica*, 12 : *C. tribuloides*.

Table 1. Quantitative anatomical characteristics in investigatd *Quercus*, *Lithocarpus* and *Castanopsis*.

botanic name	number of pores per square mm	Pore size in average (μm)	vessel length (μm)	vasicentric trachied length (μm)	fiber tracheid length (μm)	libriform fiber length (μm)
Quercus delatata	60.3-104.0	25-74	89-311	296-488	385-622	562-1036
Q. glauca	9.0-34.7	22-111	192-578	192-770	474-755	355-1036
Q. incana	72.3-136.0	15-74	133-340	266-474	281-533	167-596
Q. lamellosa	9.8-51.2	15-104	74-458	385-740	518-754	666-1110
Q. lanuginosa	9.0-78.0	15-88	207-340	429-637	548-636	636-962
Q. lineata	21.9-58.0	37-74	59-429	325-533	370-814	414-873
Q. semecarpifolia	22.6-52.8	15-104	59-399	326-577	488-740	548-918
Lithocarpus pachyphylla	11.3-45.9	22-96	207-444	385-562	548-666	459-740
L. spicata	9.0-37.7	30-118	222-474	518-784	548-888	932-1154
Castanopsis hystrix	42.0-52.8	30-103	158-370	399-548	474-666	592-740
C. indica	41.3-60.3	22-89	104-503	355-755	326-814	592-903
C. tribuloides	20.4-64.0	15-118	104-429	266-636	296-844	444-880

Table 2. Summarized anatomical characteristics in investigated *Quercus*, *Lithocarpus* and *Castanopsis*.

botanic name	pore multiple	pore density	pore size	vessel length	tyloses	septate fiber	wood parenchyma*	crystals in ray
Quercus delatata	2-3	high	small	short	+	−	sca. -unis.	+
Q. glauca	2-3	low	large	med. -long	+	−	dif. -ag. -band.	−
Q. incana	2-3	high	small	short-med.	+	−	diffuse	−
Q. lamellosa	2-3	low	large	short-med.	−	−	dif. -ag. -band.	−
Q. lanuginosa	solitary	low-medium	large	medium	+	+	banded	−
Q. lineata	2-3	medium	small	short-med.	−	−	dif. -ag.	−
Q. semecarpifolia	solitary	medium	medium	short-med.	+	−	dif. -ag. -band.	+
Lithocarpus pachyphylla	solitary	low	medium	medium	−	−	banded	−
L. spicata	2-3	low	large	medium	−	−	dif. -ag.	−
Castanopsis hystrix	2-3	medium	medium	short-med.	+	−	diffuse	−
C. indica	2-3	medium	large	short-med.	+	−	sca. -unis.	+
C. tribuloides	2-3	medium	large	short-long	−	−	dif. -ag.	−

*sca. -unis. =scattered in short uniseriate bands; dif. -ag. -band = diffuse in aggregate and banded; dif. -ag. = diffuse in aggregate.

types of rays, broad and narrow, are pretent. Broad rays measures up to 218 μm in width and are not compound but aggregate, being separated into many compound masses of ray cells by nearly longitudinal intrusions of axial elements. Narrow rays are very numerous, 1-3 seriate and range from 44-1554 μm in height. The number of rays per square millimeter ranges from 24.9-124.3. The highest number of rays per millimeter is found in *Q. pachyphylla*. Crystals are present in ray cells of *Q. delatata*, *Q. semecarpifolia* and *C. indica*.

Discussion and Conclusion

The anatomical features of 12 species belonging to three genera under Fagaceae are described in the present study. The salient anatomical features of each of the species are considered in order to contribute to the identification of taxonomically complicated Himalayan Fagaceae species, and to evaluate the probable evolutionary status of the different species on the basis of wood anatomy.

As indicated in figures and tables, the wood structure of the branches is fairly similar among the species, with differences found in pore density, pore size, length of tracheal elements, occurrence of tyloses, septate fibers and crystals in ray cells, and in the distribution of wood parenchyma. It is easily noticed that there are no fundamental differences in the wood structure among the species in these three genera which are phylogenetically closely related. The differences in anatomical characters should not be regarded as representing differences at the genus level, but the species level. *Q. glauca*, *Q. lamellosa* and *L. spicata* differ from other species by their fewer and large pores; *Q. semecarpifolia* and *L. pachyphylla* by solitary pores and banded wood parenchyma; *Q. lanuginosa* by its solitary pores, banded wood parenchyma and septate fibers; and *Q. delatata*, *Q. incana* and *Q. lineata* by higher pore density and small pores. In the other species, pore density and pore size are usually intermediate. Although it is difficult to identify species only by these anatomical characters, they are applicable for identification when used along with other diagnostic characters.

With respect to the vessel arrangement, radial porous structure is found in the all species investigated. The radial porous structure represents an evolutionary advancement over the diffuse porous (GILBERT, 1940), but it is, on the contrary, regarded as a less advanced structure than the ring porous (SHIMAJI, 1962). Solitary pores are suggested to be primitive (TIPPO, 1941). These are found in *Q. lanuginosa*, *Q. semecarpifolia* and *L. pachyphylla*, and they show the primitive status of these species. Although vessel abundance is a characteristic not yet established to have any phylogenetic importance (CARLQUIST, 1962), pore density may have some sort of inverse correlation with pore size. Therefore, *Q. incana*, which has the highest pore density and the smallest pores, may be considered as primitive and *Q. glauca*, which has the lowest pore density and the largest pores, as advanced. It is recognized that the significantly larger pores are more evolved than the small ones (RODRIGUEZ, 1957). Similarly, the simple perforation of the vessel elements also supports an advanced status for the family. According to FROST (1930), thin walled and angular vessel elements are more primitive than thick walled and rounded ones. In the investigated species vessels are thick walled and rounded, which may mean that these species are advanced. Similarly the arrangement of intervascular pits has evolved from scalariform to transitional and then to opposite and finally alternate (FROST, 1931). Therefore, alternate intervascular pitting in the investigated species is the advanced character.

The morphological features of the fibrous elements occurring in the woods of various species examined are summarized in Table 1. It can be seen that the fibrous elements are short and medium in length. Fibers are nonseptate except in *Q. lanuginosa* where few septate fibers are found. The thickness of the walls is less than 6 μm, thus falling into the category of thin walled fibers (MOSLEY, 1948). Thus, considering fibrous elements, both advanced (presence of short fibers) and primitive (thin walled) conditions are found among the Fagaceae. *Q. lanuginosa* is advanced among the species investigated, as it has short and few septate fibers. In all the species the parenchyma is predominantly apotracheal, showing the feature of primitive status.

It is concluded that the investigated species in the Fagaceae show both primitive and advanced

characters, though this family is said to be an advanced one, for it has more advanced characters than primitive ones.

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摘　要

ネパールの温帯産ブナ科のコナラ属7種，クリカシ属2種，シイ属3種について枝材の比較解剖を行った。いずれも放射孔材で道管の穿孔は単一，道管相互の壁孔は交互状配列を示す。木部柔組織は独立柔組織であるがその配列は種によって様々である。周囲仮道管，繊維状仮道管，真正木繊維がいずれの種にも存在する。放射組織は単列のものと集合状のものがある。これらの解剖学的性質に基づいて種の識別があるていど可能な事を明らかにし，これらブナ科植物の系統について考察した。

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○　東京都江東区総務部広報秘書室（〒135 東京都江東区東陽4-11-28）**続江東区の野草**　昭和61年2月10日発行。B 6判，208頁。頒価1,000円。

〝江東区の野草〟は好評の中で増刷を重ね，それを手にして，日曜日には親子・グループが散策する光景が見られるという。

本書はその続巻として前巻に収録できなかったものの中から175種を選定し，登載した。その中の一種，ユメノシマガヤツリ（夢の島蚊吊り）はオーストリア・南アフリカ原産の帰化植物で，この最初の発見地の名が与えられたものである。解説文は前書と同様，本会々員浅井康宏・加藤倍重氏の他二氏の執筆である。

○　**岡崎市の植物**　昭和60年8月31日発行，B 5判。非売品。

本書は〝新編岡崎市史，自然14〟の213頁より650頁までを抜刷したもので，内容は8章からなっている。その各章の表題と執筆者は下記のとおりである。1．岡崎市の植生（倉内一二），2．岡崎市の植物相（大原準之助），3．岡崎市の植物地理（大原準之助），4．岡崎市の植物方言名と民俗（大原準之助・本多澄夫・古田忠久），5．岡崎市の役に立つ植物（山田　弘・大原準之助），6．岡崎市高等植物目録（大原準之助・千賀敏之），7．岡崎市の蘚苔類（高木典雄・小笠原昇一），8．岡崎市および周辺の高等菌類（黒柳悦次・本多澄夫）。

この中で御気づきのように，故大原準之助氏は各章に進んで執筆されたばかりでなく，これらの広範な内容の編集の任にあたられた。あらためて，その労に敬服しつゝ御冥福を御祈りする。　（里見信生）